Department for Communities & Local Government

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CHIEF FIRE & RESCUE ADVISER

Fire and Rescue Authorities Operational Guidance

GRAs
generic risk assessments

GRA 5.1
Incidents involving electricity

Generic Risk Assessment 5.1

Incidents involving electricity

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SECTION 1

Generic Risk Assessment 5.1 Incidents involving electricity

Scope

This generic risk assessment examines the hazards, risks and control measures relating to fire and rescue personnel, the personnel of other agencies, and members of the public when dealing with incidents involving electricity.

The Fire and Rescue Authority may attend incidents where it is necessary for personnel to operate under or near high voltage electrical installations that include power lines, pylons and ground installations. At all incidents personnel must consider either that electricity cables or installations may be involved, or be in close proximity.

In general, the scope of this generic risk assessment relates to two basic types of incident:

- fires in equipment or premises or sites using, distributing or producing electricity
- rescue of casualties in contact or within close proximity to live electrical equipment.

Even low domestic voltage can be fatal; therefore it is vital crews work safely at all times in the vicinity of electricity wires, photovoltaic cells and electricity sub-stations.

Incidents involving electricity cables are on the increase, particularly the malicious ignition and theft of cables above ground.

Depending on the nature and scale of the incident a variety of significant hazards may be present, therefore, Fire and Rescue Authorities may need to consider the contents of other specific generic risk assessments in this series.

These may include:

- GRA 2.7 Rescues from tunnels
- GRA 4.2 Incidents involving transport systems – Rail.

Details of documents that contain technical and supporting information can be found in the Technical Reference section of this generic risk assessment.

Fire and Rescue Authorities must conduct their own assessments and produce their own safe systems of work (which include standard operating procedures) which detail the hazards associated with and the procedures to be adopted at incidents involving electrical

equipment. This must include training programmes, provision of equipment, levels of response etc, within the context of integrated risk management plans, local conditions, knowledge and existing organisational arrangements.

Production and distribution

The main components for the production and distribution of electricity are:

- power station, electricity production and distribution
- distribution network, along with electricity that passes from the power station to the area where it will be used (Fire Service Manual – Electricity)
- sub-stations that lower the voltage on the distribution network for consumers
- the cable network, carrying the electricity from the sub stations to the consumers
- the consumer distribution system, carrying electricity to the equipment
- photovoltaic cells/solar panels, domestic and non domestic electricity production using sunlight
- wind turbines, industrial and domestic electricity production using wind.

POWER STATIONS

Power stations may have outputs as high as 400,000 volts. The generation plant is powered by steam turbines, which may be fuelled, for example by; coal, oil, gas fired boilers, or nuclear reactor.

DISTRIBUTION NETWORK

Power stations pass the electricity they produce into the distribution network. This is a countrywide grid through which the electricity can be carried to the local networks.

Voltages of the distribution network are normally between 400,000 and 132,000 volts and may be carried on over ground pylons or laid underground. Over ground cable height means that the cables are generally inaccessible, and therefore only have to be insulated at the point where they touch the supporting pylon.

SUB-STATIONS

The voltage of the distribution network is reduced before being passed to the consumer through sub-stations that contain:

- transformers – to reduce the voltage
- cooling systems – to remove excess heat generated by the transformer
- switch gear – to control the flow of electricity into and out of the sub-station.

The reduction of the voltage from 400,000 volts to 230 volts occurs in sequential steps via a network of sub-stations supplying an ever-decreasing localised area.

These sub-stations can vary in size from a complex covering several acres, to an installation contained in a small room, above or below ground, or mounted on a pole in a rural area. These may be energised or controlled remotely. The cables carrying power to them can also vary from un-insulated overhead cables to insulated underground cables. Whatever the size and voltage of the sub-stations, they will remain under the control of the electrical distributor, even when they are located within premises owned by other persons.

RAILWAYS – see *Fire and Rescue Service Operational Guidance – Railway incidents* for further information[1].

SOLAR PANELS/PHOTOVOLTAIC CELLS

Solar panels/photovoltaic cells are used increasingly in both domestic and commercial installations. Photovoltaic cells are panels that can be attached to a roof or wall. Each cell is made from two layers of semi-conducting material, usually silicon. When light shines on the cell it creates an electric field across the layers. The cells do not need strong sunshine to work as they can still generate electricity even on a cloudy day.

A typical domestic system with several cells formed into an array, may generate 2kWp (kilowatt peak).

The system converts solar radiation into direct current at the solar panel and feeds into an inverter where it in turn is converted to alternating current and fed into the fuse box to power the household/building. The excess supply is either fed back down the electrical supply line and into the National Grid, or into battery back-up banks. In all cases this presents a potential electrical shock hazard for firefighters.

WIND ENERGY

Wind energy can be described as the harnessing and moving air by wind turbines to produce electricity. A generator converts rotational energy into electrical energy. The transformer converts the electricity from around 700V to the right voltage for distribution, typically 33,000V.

ELECTRICITY GENERATORS

See *Fire Service Manual Volume 2 Fire Service Operations Electricity* for further information.

VOLTAGES

High voltage: this is defined in national and international standards as being in excess of 1000V ac or 1500V dc. However, historically, certain precautions have been applied in the UK to systems energised at more than 650V ac. Hence the term “high voltage” is used to describe voltages exceeding 650V ac. (extract from HSG85, Electricity at Work, Safe working practices).

[1] *Fire and Rescue Service Operational Guidance – Railway Incidents*, DCLG, 2012 http://www.communities.gov.uk/publications/fire/railwayincidents

THE CABLE NETWORK

Electricity from the sub-stations is passed to the consumers by a network of either overhead or underground cables from 230 volts for a domestic customer, up to 11,000 volts for a large industrial site.

There has been an increase in malicious connection and disruption to the cable network as the cables are stolen.

Solar panels and wind turbines may also connect to the cable network.

Specific operational procedures may be required to cover incidents at power stations, sub-stations, wind turbine and solar panels incidents.

CONSUMERS INSTALLATIONS

Consumer installations vary depending on demand. These are divided into:

- small installations using 230 volts
- large installations using 415 volts.

This generic risk assessment will be reviewed for its currency and accuracy three years from date of publication. The Operational Guidance Strategy Board will be responsible for commissioning the review and any decision for revision or amendment.

The Operational Guidance Strategy Board may decide that a full or partial review is required within this period.

Significant hazards and risks

Incidents involving electricity present a wide variety of hazards and risk to fire and rescue personnel. These include:

Direct contact

Direct contact with live electricity is potentially lethal. This can be from direct or alternating voltages as well as static discharge from domestic or industrial supplies.

Arcing

Electricity can ‘jump’ through air, smoke or a column of water. The higher the voltage the more likely, and the further the electricity may ‘jump’. Arcing can also generate intense heat and ignite flammable substances in the vicinity.

Re-energising circuits and equipment

Substations generally have automatic switches which are programmed to attempt to re-energise circuits that have been broken. Some re-energising may also be caused by human error.

It cannot be assumed, therefore, that a circuit is isolated.

Residual charge

Certain high current equipment, including transmission overhead lines and high voltage equipment, including photovoltaic cells are not made safe by merely switching off the supply, and may still carry a significant residual charge sufficient to cause fatal injury. This residual charge may remain until made safe, generally by the electricity company.

Uninterruptable power supplies

An uninterruptible power supply is a device that cleans up mains power and also provides back-up power from its battery to critical electrical equipment. The purpose of an uninterruptible power supply system is installed to safeguard the electrical supply of vital or life saving equipment during a power blackout. Firefighters may go into a room expecting electrical/electronic equipment to be 'dead' because the mains power is off. But, because the equipment is linked to an uninterruptible power supply they may discover that the equipment is 'live'.

Flash down

High voltage electricity has the potential to cause death or serious injury to any person within the vicinity through flash down. This is also referred to as 'flash over' in the electricity industry.

The high voltage electricity can find a path to earth, through thick smoke or through a column of water from a monitor or branch.

Overheating transformers and cooling systems

Transformers generate significant heat and are generally cooled by the circulation of mineral oils. On occasion, the transformer overheats or is involved in a form of arcing which generates flammable gases. This may cause the transformer to rupture thus distributing burning hot mineral oil. Some switch-gear is also oil cooled and can rupture in a similar manner to transformers, with the resultant distribution of hot mineral oil which may create a significant fire ball.

Overhead lines

Overhead lines are at various voltages and are usually un-insulated.

LOW VOLTAGE

Low voltage overhead lines are suspended by wooden poles and arranged into either:

- vertical arrays of up to six lines (with the lowest cable being the neutral)
- single lines with live and neutral cores (known as 'concentric cables').

HIGH VOLTAGE

Some **high voltage** lines may also be suspended by wooden poles but can be identified as:

- usually arranged in either a horizontal array of two or three lines or
- arranged in a six cable array– three lines to each side of the pole

- separated from the wooden pole by circular insulators.

Pylons or towers are arranged with an array of three cables (or set of cables) to each side of the pylon/tower. Each side of the tower represents three phases of electricity, however, each side of the tower may have a different origin and may be operated by a different company.

Yellow “danger of death” signs must only be present on high voltage poles or towers. In practice however, this is not always the case and they are sometimes attached to low voltage poles.

Overhead line pylons or poles are denoted by a unique identification number plate. In instances where each side of the pylon/pole is supplied by different electricity companies or sources, there will be two identification number plates.

Wind energy

At any incident involving a wind turbine, electrical hazards include those typical of any other electrical producing equipment. Short circuits, overheated alternators and gearbox oils are all known to have caused fires at Wind Farms. Typically, generators may also overheat.

Photovoltaic cells/solar panels

At any incident involving photovoltaic cells/solar panels, there is a potential electrical hazard from energy produced by the units. Even when isolated at the inverter or fuse box, the system may remain ‘live’ between the panels and the isolation point. This presents a potential for electrical shock hazard for firefighters at incidents. Not only during daylight hours, but also where there are low levels of light as the cells do not need strong sunshine to generate electricity. Moonlight and artificial scene lighting can be sufficient to allow panels to generate direct current electricity.

Battery racks

Larger electricity sub-stations will usually have a building with racks of 12 volt batteries. The hazards presented by these are:

- stored electrical charge
- hazardous substances such as sulphuric acid.

Ground becoming live

When high voltage equipment is in contact with the ground (or an uninsulated object touching the ground), there is a risk of the ground itself transferring the current to any person present. This effect only extends to a few metres and the voltages are higher closer to the point of contact.

There may be occasion when the high voltage equipment/cable is in contact with a vehicle but not the ground. The vehicle tyres may insulate the electricity from the ground. Any personal contact with the vehicle and ground at the same time will offer a path for the electricity to the ground and may electrocute and seriously injure the person making contact.

Blown-off covers

High voltage underground cables are insulated with oil or gas under pressure. Overheating can lead to fire and an increase in the gas/oil pressure. This pressure can in turn lead to concrete covers on the underground link boxes being violently blown-off and often the blowing-off of bituminous insulation.

Some underground cables will link with above ground pillar feeders which also have potential to overheat. Fires will present additional hazards such as toxic fumes.

Acrid smoke

Especially when other equipment and polyvinyl chloride, commonly abbreviated as PVC, insulation material is involved, there is a potential for fires at electrical installations to produce large quantities of thick acrid smoke.

Irrespirable atmospheres

Some enclosed electrical installations are protected by fixed installations including carbon dioxide/gas flooding systems. There must be a warning sign and light outside any compartment.

Confined access for firefighting and rescue

Some entrapments or fires may be located in hard to reach places such as tunnels or runs.

Hazardous substances

- **POLYCHLORINATED BIPHENYLS (PCB's)**
  These are highly toxic, and can lead to chronic illnesses including liver damage and skin rashes. They pollute the environment, accumulate into the food chain and are not biodegradable. Although used as insulators they are now mainly phased-out. However, they may still be present in varying proportions, in privately owned transformers.

- **SULPHUR HEXAFLUORIDE GAS (SF_6)**
  Is used at very low pressures to insulate certain areas of sub-stations and for arc extinction within switchgear. Sulphur hexafluoride gas in its pure form is inert, colourless, non-flammable, non-toxic, and five times heavier than air and a greenhouse gas. In sub-stations it is sealed within compartments that must have a warning sign denoting SF6 presence on the exterior. It can only escape in fault conditions, which includes fires, when it can generate toxic and corrosive gases or powder that can cause skin burns and severe damage to eyes.

- **FUELS/CHEMICALS/OILS**
  As well as bulk fuels to generate the electricity, smaller quantities of other fuels and chemicals including acids, gases, liquid petroleum gases, petroleum and diesel may be present at electrical installations.

Luminous discharge tubes (neon signs)

If a luminous discharge tube is broken, it can lead to the liberation of mercury vapour. Inhaled mercury vapour can lead to flu-like symptoms, chest tightness, respiratory illnesses and kidney failure.

Typically, a luminous discharge tube will require a high voltage (such as 3,000V) to start up, but the voltage is then reduced once the light is working. If a luminous discharge tube breaks or goes out, this does not necessarily mean the electrical circuit is broken. Connections and 'jumper wires' between the tubes may still be live.

Site security measures

Towers, pylons and poles have anti-climbing guards. These are typically barbed or have razor-type wire deterrents. Where these have to be overcome, there are clear hazards to firefighters.

Other site security measures may present similar hazards such as barbed wire fencing.

Missing warning and identification signs

Electric hazard warning and identification signs and markings may be missing due to:

- Vandalism
- Melting in proximity to fire. For example, this is known to have happened at glass reinforced plastic covered substations.

Noise

Some switches may be in open-air and make considerable noise when closing the circuit.

Falls from height

Some rescues may necessarily involve working at height and the consequential hazards.

Other hazards

Additional electrical hazards which may be encountered at incidents include: booby traps created by direct wiring of door and window handles, occupiers tampering with the consumer unit, illegal and illicit drug labs and cannabis cultivation using complex wiring and illumination.

Key control measures

Planning

Planning is key to enhancing the safety of firefighters and others likely to be affected by the Fire and Rescue Authoity's operations. Each Fire and Rescue Authority's integrated risk management plan will set standards and identify the resources required to ensure safe systems of work are maintained.

Each Fire and Rescue Authority must assess the hazards and risks in their area relating to this generic risk assessment. The assessment must include other Fire and Rescue Authority's areas where 'cross border' arrangements make this appropriate.

Site-specific plans must be considered for locations where the hazards and risks are significant and plans must take into account and specify any variation from the normal operational capability of personnel, appliances and equipment. In particular, recognition must be given to the physical and psychological pressures that an operational incident may apply to fire and rescue personnel.

Site-specific plans must include:

- levels of response
- relevant standard operating procedures
- tactical considerations, including rendezvous points, appliance marshalling areas and access points
- identification and where necessary, the formal notification to person(s) responsible for the site of any Fire and Rescue Authority operational limitations.

Planning is underpinned by information gathering, much of which will be gained through inspections or visits by fire and rescue personnel – for example, those covered by section 7(2)d and 9(3)d of the *Fire and Rescue Services Act 2004*.

Information must also be gathered and used to review safe systems of work from sources both within and outside the Fire and Rescue Authority, including:

- fire safety audits
- incident de-briefs
- health and safety events
- local authorities
- local resilience forums.

Involving others in planning is an effective way to build good working relations with partner agencies and other interested parties, such as site owners.

Fire and Rescue Authorities must ensure systems are in place to record and regularly review risk information and that new risks are identified and recorded as soon as practicable.

Fire and Rescue Authorities must ensure that the information gathered is treated as confidential, unless disclosure is made in the course of duty or is required for legal reasons.

Fire and Rescue Authorities must consider the benefits of using consistent systems and formats to record information from all sources. Consideration must also be given to how timely access to information will be provided to support operational decision-making.

Information needs will vary in proportion to the size and nature of the incident. The capacity of fire and rescue personnel to assimilate information will vary in relation to the complexity of the incident. Therefore, arrangements may need to be flexible and be based on more than one system.

Further guidance on planning can be found in *Fire and Rescue Service Operational Guidance, Operational Risk Information:* www.gov.uk/government/publications

Specific planning regarding this generic risk assessment subject must include site visits to assist personnel to recognise and gain knowledge of:

- different types and design of electricity production installations
- different types and design of electricity distribution systems
- different types and design of solar panels and their fixing methods
- safety features for the isolation of electricity supplies
- availability and contact details of any on-site engineers with specialist knowledge
- availability and location of any site specific specialist equipment and operating instructions.

Planning, along with risk assessments and any relevant guidance, must be the basis for the development of standard operating procedures and the provision of suitable equipment.

Competence and training

When formulating a competence and training strategy, Fire and Rescue Authorities must consider the following points:

- Those tasked with carrying out the specific risk assessment and developing procedures to deal with this incident type are competent
- Personnel are adequately trained to deal with hazards and risks associated with electricity and electrical installations
- The level and nature of training undertaken must be shaped by an informed training needs analysis. The analysis must take account of Fire and Rescue Authority guidance on the competency framework, national occupational standards and any individual training needs
- Training and development programmes:
  - must follow the principles set out in national guidance documents
  - must generally be structured so that they move from simple to more complex tasks and from lower to higher levels of risk
  - will typically cover standard operational procedures as well as ensuring knowledge and understanding of equipment and the associated skills that will be required to use it

  - must consider the need for appropriate levels of assessment and provide for continuous professional development to ensure maintenance of skills and to update personnel whenever there are changes to procedure, equipment, etc
  - must involve personnel involved in other processes that support the emergency response such as planners devising procedures and people procuring equipment.
- Specific training requirements for incidents involving electricity and electrical installations will include the standard operating procedure and the equipment to be used
- Training outcomes must be evaluated to ensure that the training provided is effective, current and it meets defined operational needs as determined by the Fire and Rescue Authority's integrated risk management plan.

Fire and Rescue Authorities must ensure that their personnel are provided with adequate initial training to identify the hazards and risks and procedures necessary to deal with incidents involving electricity.

Arrangements must be in place to ensure these skills are maintained through appropriate training and ensure personnel are informed of any changes to procedure or technological change.

Consideration must also be given to establishing and maintaining contact with electricity and electrical equipment suppliers or trade associations so that new initiatives within the industry can be identified and training interventions can be kept current.

Safe systems of work

RESCUES AND FIREFIGHTING:
When committing to rescue and fire fighting activities, always ensure:

- supplies are isolated
- stored charge/energy is discharged
- always assume the system is live until the relevant power company engineer has proven otherwise ie 'permit to work' certificate.

Command and control

The Incident Commander must follow the principles of the current national incident command system.

Prior to committing personnel into any hazard area, the Incident Commander must take account of the actual information available regarding the incident at the time. This will assist them in making effective operational decisions in what are recognised as sometimes dangerous, fast moving and emotionally charged environments.

A thorough safety brief prior to deployment of personnel within the hazard zone must be carried out.

The Incident Commander must request the attendance of the relevant power company's electrical engineer. Fire control centres must maintain a current list of contacts. Contact and asset information must be available on each tower and substation involved in an incident.

The Incident Commander must ensure that all personnel are clear regarding their role in the incident.

Where electrical hazards are deemed to present a hazard the Incident Commander must ensure that arrangements have been made for the electricity to be isolated and, if necessary, discharged to earth before the incident is dealt with.

Following a risk assessment the Incident Commander must ensure personnel do not:

- enter any enclosure surrounding electrical apparatus
- climb any steel tower, structure or pole supporting overhead lines
- manipulate ladders or long objects in close proximity to any electrical equipment or overhead lines
- spray water or foam directly onto live electrical equipment.

Due to dual circuits or stored charge remaining in cables or equipment, Incident Commanders and personnel must be aware that switching off the supply to overhead lines, cable transformers and switch gear does not necessarily render it safe, Where electrical apparatus is involved, the relevant power company's engineers must undertake the necessary operations to allow controlled working at the scene of the incident.

This will be achieved in two stages following the actions and advice of the attending electrical engineer.

STAGE – 1

The apparatus will be made dead by switching off the normal supply if the engineer agrees, it may be possible at this stage to rescue human life or take action to contain a fire, however, equipment must still be considered as 'live' at this stage.

STAGE – 2

The apparatus will be made safe by disconnection from the normal supply and connecting all conductors to earth. Following this stage the engineer will issue a certificate to the officer-in-charge stating that it is safe for work to proceed on the equipment without restriction.

Overhead line and pole mounted electrical apparatus present more electrical hazards than cable and ground mounted apparatus, and the engineer may not agree to any work being carried out until the overhead line or pole equipment has been made safe. This could apply even when life is at risk.

PRECAUTIONS FOR WORK ON ISOLATED EQUIPMENT

Adequate precautions must be taken to prevent electrical equipment that has been made dead, from becoming live or electrically charged while personnel are working on that equipment. More than one supplier may feed electrical circuits.

Fire and rescue personnel must ensure that:

- breakers or switches are locked off
- equipment is assessed for alternative power sources and isolated from them
- isolations are carried out by the authorised competent person of the supply company.

WORK ON OR NEAR LIVE CONDUCTORS AND OVERHEAD LINES

Steps must be taken to have the live conductors isolated and grounded. No person must be engaged in any work activity on or near any live conductor unless the conductor is suitably covered with insulating material to prevent danger. This information must be confirmed with the power supply company representative, prior to commencement of any activity.

Overhead lines are normally un-insulated and if an object gets too close, it is possible that electricity will jump over a distance to reach earth via the object. It must always be assumed that an overhead power line can be lethal, and all objects, including masts, poles, ladders, appliances, tools and personnel must be kept far away from power lines at all times and must not encroach within the safety zone.

A high-pressure jet playing on an overhead line with horizontal conductors, may cause them to clash resulting in arcing. This could lead to breakage of the conductor resulting in live conductors falling to the ground. High-pressure jets playing onto overhead conductors may also result in earth leakage currents through the water stream to ground. This may cause the branch to become live, with potentially fatal consequences.

If a casualty is sensible and coherent and is not in close proximity to a conductor, but is within the hazard zone, they must be encouraged to remain in the same position until the electrical conductor can be isolated.

Information must be obtained from the power supply company before attempting rescue of a live casualty. Rescue poles may be considered to assist rescue, following a risk assessment.

Safety Officer(s)

The early appointment of one or more Safety Officer(s) will help ensure that risks are either eliminated or reduced to an acceptable level.

A safety decision-making model must be used to brief Safety Officers regarding the nature of the incident, the allocated task and prevailing hazards and risks. The Incident Commander must confirm that the Safety Officer understands:

- their role and area of responsibility

- allocated tasks
- lines of communication.

Those undertaking the Safety Officer role must:

- be competent to perform the role
- ensure personnel are wearing appropriate personal protective equipment
- monitor the physical condition of personnel and/or general or specific safety conditions at the incident, in accordance with their brief
- take any urgent corrective action required to ensure safety of personnel
- update the Incident Commander or senior safety officer regarding any change in circumstances
- not be engaged in any other aspect of operations, unless this is required to deal with a risk critical situation.

The role of a Safety Officer can be carried out by any of the Fire and Rescue Authority roles, but the complexity of the task, size of the incident and scope of responsibility must be considered by the Incident Commander when determining the supervisory level required.

Safety Officers must wear nationally recognised identification to indicate they are undertaking the 'Safety Officer' role.

Fire and Rescue Authorities must ensure that training and other measures (such as aide-memoirs) are in place and available to support those personnel liable to undertake this role.

Personal protective equipment

Fire and Rescue Authorities must ensure that any personal protective equipment provided is fit for purpose and meets all required safety standards. When choosing suitable protective garments, the standard of clothing worn beneath the specialist personal protective equipment must also be taken into account. Consideration must also be given to the selection of suitable sizes and gender specific requirements of the personal protective equipment.

Personal protective equipment must also take account of the need for rescuers to be visible against the operational background including night working and for the Incident Commander and other managerial and functional roles (defined in the national incident command system) to be distinguishable.

All personnel must use appropriate levels of service provided personal protective equipment and respiratory protective equipment as determined by the safe system of work.

Use of electrical gloves

The decision to use electrical gloves must always be taken with extreme caution.

Special rubber gloves/gauntlets carried on many appliances have their greatest use in dealing with low voltage systems normally found in business, industrial and private premises. They must be worn when removing persons from contact with electrical wiring, for moving electric wiring that may prove a danger to operations and work of a similar nature.

Where system voltages are deemed high voltage, or it is not possible to verify the actual value, the only safe course of action is to ensure that the supply is cut off and declared safe. Electrical rubber gloves are not adequate in such circumstances.

Fire and Rescue Authority generic control measures

Direct contact with cables and equipment is to be avoided until all safeguards have been implemented.

The primary control measures employed by the Fire and Rescue Authority at incidents involving electrical hazards will be to:

- isolate the electrical supply
- maintain a safe distance
- where necessary, await an engineer to remove any residual charge.

Especially where there is no risk to life, the Fire and Rescue Authority will adopt defensive control measures to eliminate the hazards presented by electricity at operational incidents.

Where the electricity cannot be made safe quickly, Incident Commanders may adopt offensive tactics to save 'saveable life' where:

- a risk assessment has been made
- voltage is below 1,000V
- electrical safety gloves are used. NOTE: these must be inspected before use
- no water or foam directly onto live equipment
- precautions are taken when carrying metal ladders
- keeping public clear.

WARNING!

DO NOT ASSUME HIGH VOLTAGE EQUIPMENT IS ISOLATED OR SAFE UNTIL A WRITTEN PERMIT TO WORK IS GIVEN BY THE ELECTRICITY INDUSTRY AUTHORISED PERSON.

WARNING!

DO NOT TO ASSUME THE ABSENCE OF WARNING SIGNS DENOTES SAFE CONDITIONS.

Safe approach distances

In normal circumstances fire crews can work below overhead lines providing they follow a safe system of work.

When applying water, working in thick smoke, or working in substations/electrical installations, minimum safe approach distances need to be maintained. These safe approach distances are summarised in the table and diagram below.

Electricity companies will only authorise approaching within 5 metres of high voltage equipment and installations upon issue of a written 'permit to work' from the electricity industry's 'authorised person'.

If it is suspected that the casualty is still alive, the 'authorised person' may give verbal permission to rescuers at the same time as writing the permit to work.

Rescues	Minimum safe approach distance
When carrying out a rescue in the vicinity of overhead lines, substations and other electrical equipment belonging to the electricity supply industry.	5 metres from electrical conductors or anything touching it
Other operational incidents	
Not using hose	**Minimum safe approach distance**
When using ladders/aerial appliances or tall equipment	10 metres
In dense smoke or flames approaching conductor	10 metre corridor
Using hose	
When using hand-held jets	20 metre corridor
When using monitors (ground or aerial)	30 metre corridor

Extract from *Fire Service Manual Volume 2 Fire Service Operations Electricity.*

The Fire Service Manual Volume 2: figure 4.2, gives a diagrammatic view of the minimum safe approach distances (not reproduced).

Rescues involving low voltage

- initial efforts to isolate supply
- follow electrical installations flow chart in the F*ire and Rescue Service Electricity Manual*
- consider use of electrical rated gloves and non-conducting materials.

Firefighting with overheated transformer (or oil filled switchgear)

- maintain 20 metre corridor for branches and 30 metres for monitors
- consider use of foam
- no water or foam directly onto live equipment
- monitors on spray, aimed to ground and not beyond transformer safety screen
- full firefighting personal protective equipment, visors down, fire hoods up and fire gloves within 50 metres
- liaison with 'authorised person'.

Incidents involving uninterrupted power supplies

- for uninterrupted power supplies systems providing back-up to whole buildings, there must be a 'cut-off' for it, near the 'cut-off' switch for the mains power
- for smaller individual uninterrupted power supplies, these can pose a particular hazard as they will stay live until their individual on/off switches are operated
- firefighters must treat all electrical/electronic equipment, especially personal computers as being potentially 'live' and not deliberately direct water upon them or come into contact with damaged or suspect equipment unless they have been assured that the item does not have a uninterrupted power supplies or that, if it has, it has been turned off.

Rescues or incidents involving photovoltaic cells/solar panels

- Isolate mains power and turn off solar isolation switch, which may be located on either, the main fuse board or near the inverter. The solar panels and the wiring to the inverter/fuse board will still remain live
- Locate the inverter and solar panel cabling and warn all personnel of location
- Cordon off area where photovoltaic array could dislodge and fall
- Minimum personnel working below arrays
- Arrange for attendance of the electricity company to confirm equipment is 'dead' or 'isolated'.

Incidents involving wind energy

- liaise with the authorised person on arrival eg the wind farm's authorising engineer
- ensure isolations are carried out by the authorised person.

Involvement of battery racks in fire

- maintain safe approach distance when applying firefighting medium
- consider fixed installation
- consider bulk carbon dioxide or other gas suppression systems

- request hazardous materials and environmental protection adviser (sulphuric acid hazard)
- consider use of foam
- consider containment of fire water run-off.

Ground becoming live

- leave people in vehicles where possible until receipt of 'permit to work' from authorised person
- attempt to get people to drive clear of the electrical conductor
- if unavoidable, such as a fire endangering life, people must be instructed to:
  - Jump well clear with both feet together
  - Do not touch the vehicle and ground at the same time
  - Run well clear with leaping strides
  - Fire and Rescue Authority to then cordon area with at least 5 metres clearance.

Blown-off covers (underground cables involved with fire)

- request attendance of public utility company
- maintain defensive mode for voltages over 1,000 V
- consider use of carbon dioxide extinguisher to limit fire spread.

Acrid smoke

- approach from upwind
- breathing apparatus procedures
- consider limiting exposed personnel.

Fixed installations

- if there is a fixed installation that has not activated, then consider charging it or turning it on as a firefighting tactic
- liaise with the electricity company engineer.

Entry into irrespirable atmospheres (CO_2, inert gas or confined space)

- approach from upwind
- breathing apparatus procedures
- consider alternatives
- consider gas monitoring equipment
- consider permits to work.

Fire in tunnels

- no entry without the permission of the 'authorised person'
- consider use of bulk carbon dioxide to extinguish.

Suspected involvement of polychlorinated biphenyls

- until confirmed otherwise, treat all non-electricity company transformers as if they contain polychlorinated biphenyls
- breathing apparatus must be worn if fire fighting or working within 20 metres
- consider use of chemical protective clothing when not involved with heat and fire
- request attendance of hazardous materials and environmental protection adviser and environmental protection equipment
- contain any leaks and run-off.

Entry into sulphur hexafluoride (SF6) covered area

- use breathing apparatus procedures
- enter area upon permission of authorised person
- approach from upwind
- consider use of chemical protection clothing to facilitate decontamination of toxic and corrosive by-products
- consider tactical ventilation
- consider gas monitoring equipment.

Luminous discharge tubes involved in incident

- isolate using 'firefighters switch'
- always assume high voltage
- where isolation is not possible request attendance of public utility
- breathing apparatus if there is a risk of tube smashing due to mercury vapour hazard
- decontamination procedures if a tube smashes in vicinity of firefighters.

Contacting electricity company

Contacting the wrong company will result in delays as some work can only be done once the correct 'authorised person' is on scene and able to issue a 'permit to work'. Some electrical installations, including all towers, poles, transformers and sub-stations can be identified with:

- the company name
- the contact phone number
- any identification number on the plate.

It must be noted that some electricity towers are operated by two companies, so there may be two plates. Some towers also have plates with coloured bands. This plate identifies the particular circuit and details must also be passed to control.

The following information must be given to control and passed to the correct company or companies:

- address
- identification numbers and colours
- physical description of the site
- distances from live equipment
- whether incident is at ground level, above or below
- weather conditions on site
- current plan
- any time limits or other pressures
- any other relevant information
- use aerial appliance where safe
- liaise with on-site engineer on overcoming issues
- consider cutting wire prior to creating access
- post incident security.

Missing warning/identification signs

- do not assume electrical equipment is safe, liaise with on-site engineer
- warn and remind personnel to check with site specific information.

Noise from switch gear

If there is significant noise from switch gear at the scene of an operation, consideration must be given to:

- eliminating the noise (through the electricity company)
- limiting the exposure of those affected (time or distance)
- protecting the hearing of those affected.

Falls from height

- where operations involve the risk of falling from height, working at height procedures must be followed.

Other hazards

- contact and liaise with the local electricity company
- follow the appropriate procedures.

General reminders (Source: Energy Network Association Safety Advice for the Fire Service)

- Electricity systems carry voltages up to 400,000 volts and can be supported by wooden poles or steel towers
- Even domestic voltages (230V) can be lethal
- Never assume that electrical equipment is dead, even if the wires have fallen or broken
- The power can be switched back on at any time, without warning
- Touching electricity wires or objects/persons/vehicles in contact with the wires can be fatal
- Electricity can jump gaps
- Trees, string, ropes, highway crash barriers and water can conduct electricity
- Once an electricity wire is on the ground, you do not have to touch it to be killed. The current will travel a reasonable distance through the ground
- Rubber boots will not protect you
- Look out and look up for overhead wires before you start. Most wires are not insulated
- Always carry long objects horizontally
- The electricity company emergency telephone numbers must already be known by your control centre. Call the electricity company urgently with a precise location of the incident
- Do not start fighting a fire in a substation before the electricity company has confirmed that it is safe to do so
- Do not approach a crashed vehicle if it is in contact with electricity wires until the electricity company has confirmed that it is safe to do so
- If in doubt, keep 5 meters away and seek advice from the electricity company.

Post-incident

The following measures must be considered to help eliminate or remove risks after an incident, as appropriate to the nature and scale of the incident:

- Any safety events; personal injuries, exposure to hazardous substances or near-misses must be recorded, investigated and reported in line with legislative requirements such as *Reporting of Injuries Diseases and Dangerous Occurrence Regulations 1995*, etc
- Arrangements must be in place to either remove all contamination from personal protective equipment or to ensure it's safe and appropriate disposal and to check that the equipment maintains the agreed levels of integrity and protection for the wearer throughout its lifecycle

- As appropriate, occupational health support and surveillance follow up
- Conduct a de-brief to identify and record any ‘lessons learned’ from the incident. De-briefs will range in complexity and formality, proportionate to the scale of the incident and in line with individual Fire and Rescue Authority’s procedures
- Consider any changes required to safe systems of work, appliances or equipment in the light of any lessons learned from debriefs or from safety events
- Consider the need to review existing information held on a premises or location, or the need to add a new premises or location into future preplanning eg by adding to visit or inspection programme
- Personnel must be supported and monitored to identify whether they are experiencing any adverse affects and to check whether they would benefit from accessing counselling and support services
- Consideration must be given to arranging for personnel to make a contemporaneous written record of their actions. This information may be used to assist in any internal or external investigations or enquiries that follow any incident eg Coroner’s Court, public enquiry, etc.

Technical references	
1	Section 5.1, A *Guide to Operational Risk Assessment, Fire Service Guide Vol 3*, HMFSI, 1998
2	Strattman, Wayne, How Luminous Tubes Work, www.signweb.com
3	HSG 230, *Keeping Electrical Switchgear Safe*, Health & Safety Executive, 2002, HMSO
4	BS 697:1986, *Specification for Rubber Gloves for Electrical Purposes* (5th revision), 30 Apr 1986 BSI
5	The Electricity at Work Regulations 1989, HMSO, 1989
6	Rescues Near Electrical Hazards, 'Dear Chief Officer Letter', 14/1997 – B & "Dear Fire master" Letter 13/1997 – B
7	Guidance for UK Fire and Rescue Services – Dealing with incidents on National Grid High Voltage Lines
8	Energy Network Association – Safety Advice for the Fire Service http://www.energynetworks.org/modx/assets/files/electricity/she/public_safety/leaflets/FireService_071112.pdf
9	Electricity – Fire and Rescue Service Manual – Volume 2: Fire Service Operations Published: 30 Jan 1998 ISBN: 9780113411122 http://www.tsoshop.co.uk/bookstore.asp?FO=1276405&DI=3160
10	Physics and Chemistry for Firefighters – Fire Service Manual – Volume 1: Fire Service Technology, Equipment and Media – Published: 29 Apr 1998 ISBN: 9780113411825
11	Fire service manual Volume 4 Fire service training Guidance, compliance and training framework for rope working
12	Fire and Rescue Service Circular 28/2007 – Fire Service Risk Management for Methamphetamine and other illicit drug laboratories
13	Electricity at work, Safe working practices. HSG85. Health and Safety Executive
14	Generic Risk Assessment 1.1: Emergency response and arrival at the scene
15	Generic Risk Assessment 3.1: Fighting fires in buildings
16	Generic Risk Assessment 3.2: High Rise Firefighting, Version 2 – September 2008
17	Generic Risk Assessment 3.4: Fighting fires in open rural areas
18	Generic Risk Assessment 3.5: Fighting fires in farms
19	Generic Risk Assessment 4.2: Incidents involving transport systems – Rail
20	Generic Risk Assessment 4.3: Incidents involving transport systems – Air
21	Generic Risk Assessment 4.1: Incidents involving transport systems – Road
22	Generic Risk Assessment 5.9: Incidents involving asbestos containing materials
23	Generic Risk Assessment 5.10: Working at heights
24	Generic Risk Assessment 5.8: Flashover, backdraught and fire gas ignitions
25	Renewable UK. Wind Turbine Safety Rules (WTSR) Version 3.
26	Renewable UK. How it works. http://www.renewableuk.com

Useful information
Hooper, Edwin, Beckinsale's: The Safe Use of Electricity, 1993 (2nd Ed), RoSPA

SECTION 2

Summary of Generic Risk Assessment 5.1 Incidents involving electricity

Task – Pre-incident and initial

Ref. No.	Activity	Hazard	Risk	Persons at risk	Control measures
1	Equipment identification	Direct contact with live electricity	Death, serious injury	Fire and rescue personnel Public Other agencies	All personnel receive information and training on the hazards associated with firefighting where electricity is involved Operational Incident Commander to liaise with power company engineer on arrival at incident Isolate electricity supply and make safe Personnel to wear full fire fighting kit Personnel to be aware of safe working distances If at a fixed installation and it has operated, breathing apparatus to be worn If sulphur hexafluoride involved in fire, use chemical protection suit and positive pressure breathing apparatus If required set up decontamination Ambulance and first aid standing by

Ref. No.	Activity	Hazard	Risk	Persons at risk	Control measures
					Do not direct jets from spray onto electrical equipment unless safety certificate issued by power company's engineer Use rubber gloves only to the design voltage, never exceed it Electrical rubber gloves tested according to the manufacturers instructions If equipment voltage unknown, then it must be made safe, prior to work.

Task – As the incident develops:

Ref. No.	Activity	Hazard	Risk	Persons at risk	Control measures
1	All tasks including: Approaching Electrical installations Fire fighting Rescue	Direct contact with live electricity	Death, serious injury	Fire and rescue personnel Public Other agencies	Follow advice from authorised person Written permit to work Incident command system Personal protective equipment, eg rescue poles, electrical gloves for low voltage systems Training Standard operating procedure Authority's risk assessment process.
		Arcing high voltage equipment	Death, serious injury	Fire and rescue personnel Public Other agencies	Follow advice from authorised person Written permit to work Incident command system Personal protective equipment, eg rescue poles, electrical gloves for low voltage systems Training Standard operating procedure Authority's risk assessment process.

Ref. No.	Activity	Hazard	Risk	Persons at risk	Control measures
		Re-energising apparatus	Death, serious injury	Fire and rescue personnel Public Other agencies	Follow advice from authorised person Written permit to work Incident command system Personal protective equipment, eg rescue poles, electrical gloves for low voltage systems Training Standard operating procedure Authority's risk assessment process.
		Uninterrupted power supplies	Death, serious injury	Fire and rescue personnel Public Other agencies	Treat as 'live' Follow advice from authorised person Written permit to work Incident command system Personal protective equipment, eg rescue poles, electrical gloves for low voltage systems Training Standard operating procedure Authority's risk assessment process.

Ref. No.	Activity	Hazard	Risk	Persons at risk	Control measures
		Residual charge in high voltage equipment	Death, serious injury	Fire and rescue personnel Public Other agencies	Follow advice from authorised person Written permit to work Incident command system Personal protective equipment, eg rescue poles, electrical gloves for low voltage systems Training Standard operating procedure Authority's risk assessment process.
		'Flashdown' through smoke or water	Death, serious injury	Fire and rescue personnel Public Other agencies	Follow advice from authorised person Written permit to work Incident command system Personal protective equipment, eg rescue poles, electrical gloves for low voltage systems Training Standard operating procedure Authority's risk assessment process.

Ref. No.	Activity	Hazard	Risk	Persons at risk	Control measures
		Overheating transformers (and other oil filled equipment)	Death, serious injury	Fire and rescue personnel Public Other agencies	Follow advice from authorised person Written permit to work Incident command system Personal protective equipment, eg rescue poles, electrical gloves for low voltage systems Training Standard operating procedure Authority's risk assessment process.
		Overhead lines, underground cables, pillar feeders and tunnels	Death, serious injury	Fire and rescue personnel Public Other agencies	Follow advice from authorised person Written permit to work Incident command system Personal protective equipment, eg rescue poles, electrical gloves for low voltage systems Training Standard operating procedure Authority's risk assessment process.

Ref. No.	Activity	Hazard	Risk	Persons at risk	Control measures
		Battery racks (stored charge)	Death, serious injury	Fire and rescue personnel Public Other agencies	Follow advice from authorised person Written permit to work Incident command system Personal protective equipment, eg rescue poles, electrical gloves for low voltage systems Training Standard operating procedure Authority's risk assessment process.
		Ground becoming live (conductor in contact with ground)	Death, serious injury	Fire and rescue personnel Public Other agencies	Follow advice from authorised person Written permit to work Personal protective equipment Incident command systems Standard operating procedure Authority's risk assessment process.
		Blown-off covers (from underground cable runs)	Death, serious injury	Fire and rescue personnel Public Other agencies	Follow advice from authorised person Incident command system Personal protective equipment Voltage systems Standard operating procedure Authority's risk assessment process.

Ref. No.	Activity	Hazard	Risk	Persons at risk	Control measures
		Acrid smoke at fires	Death, serious injury, respiratory illness	Fire and rescue personnel Public Other agencies	Personal protective equipment Breathing apparatus Standard operating procedure Environmental monitoring.
		Irrespirable atmospheres (fixed installations)	Death, serious injury, respiratory illness	Fire and rescue personnel Public Other agencies	Personal protective equipment Breathing apparatus Chemical protection suit Standard operating procedure Gas monitoring.
		Confined access (for rescues and firefighting)	Death, serious injury	Fire and rescue personnel Public Other agencies	Follow advice from authorised person Written permit to work Incident command system Personal protective equipment Standard operating procedure Authority's risk assessment process Gas monitoring.
		Polychlorinated biphenyls	Ingestion, respiratory injury	Fire and rescue personnel Public Other agencies	Personal protective equipment Breathing apparatus Chemical protection suit Standard operating procedure Gas monitoring.

Ref. No.	Activity	Hazard	Risk	Persons at risk	Control measures
		Sulphur hexafluoride (SF6)	Ingestion, respiratory illness	Fire and rescue personnel Public Other agencies	Personal protective equipment Breathing apparatus Chemical protection suit Standard operating procedure Gas monitoring.
		Sulphuric acid (from battery racks)	Death, serious injury, burns, respiratory illness	Fire and rescue personnel Public Other agencies	Personal protective equipment Breathing apparatus Chemical protection suit Standard operating procedure Gas monitoring.
		Mercury vapour (from smashed luminous discharge tubes)	Ingestion, respiratory injury	Fire and rescue personnel Public Other agencies	Personal protective equipment Breathing apparatus Standard operating procedure Gas monitoring.
		Site security measures (barbed or razor wire)	Cuts	Fire and rescue personnel Public Other agencies	Use of suitable personal protective equipment.
		Falls from height	Death, serious injury	Fire and rescue personnel Public Other agencies	Follow advice from authorised person, written permit to work Incident command system Personal protective equipment Working at height procedures must be followed.

Ref. No.	Activity	Hazard	Risk	Persons at risk	Control measures
		Noise from switchgear closing	Hearing loss	Fire and rescue personnel Public Other agencies	Eliminating the noise (through the electricity company) Limiting the exposure of those affected (time or distance) Protecting the hearing of those affected.

Task – Post-incident

Ref. No.	Activity	Hazard	Risk	Persons at risk	Control measures
1	Dealing with contaminated waste	Contaminated personal protective equipment	Burns, inhalation, ingestion	Fire and rescue personnel Public Other agencies	Personal protective equipment, training, standard operating procedure, service risk assessment process.